SECTION 1: OVERVIEW

1.1 INTRODUCTION

This document presents technical information to support the Agency's analyses and complements "Economic Analysis of Proposed Effluent Guidelines and Standards for the Construction and Development Category," EPA-821-R-02-008, and "Environmental Assessment for Proposed Effluent Guidelines and Standards for the Construction and Development Category," EPA 821-R-02-009.

A summary of the information contained in the chapters of this document is as follows:

- Chapter 2 presents background information on the legal authority for effluent limitation guidelines and the existing EPA storm water program.

- Chapter 3 presents a summary of the data collection activities conducted to support the proposal.

- Chapter 4 summarizes the characteristics of the construction and development industry, including major indicators of industry size and annual construction activity.

- Chapter 5 presents information and data on erosion and sediment control (ESC) best management practices (BMPs) used by this industry, including applicability, costs, and efficiencies.

- Chapter 6 presents a description of the regulatory options considered by EPA for developing the proposal, as well as a walk-through of the provisions of each proposed option.

- Chapter 7 presents the methodology used by the Agency to estimate the costs of the proposed options.

1.2 SUMMARY AND SCOPE OF PROPOSAL

The proposed rule contains three options for controlling storm water discharges from construction sites.

- Option 1 would establish inspection and certification provisions to ensure proper implementation of controls. This option would apply to all construction sites disturbing one or more acres of land required to obtain a permit under the existing National Pollutant Discharge Elimination System (NPDES) storm water regulations. This option would amend the NPDES regulations at 40 CFR Part 122, but would not create effluent limitation guidelines.

- Option 2 would add minimum requirements for preparation of a Storm Water Pollution Prevention Plan (SWPPP) as well as minimum requirements for sizing sediment basins, installing erosion and sediment controls, providing temporary stabilization to exposed soils, and conducting regular inspections. Option 2 would apply to all sites that disturb five or more acres of land, consistent with the permitting requirements of the Phase I NPDES storm water regulations. This option would create a new effluent guidelines category at 40 CFR Part 450 and would also modify 40 CFR Part 122.

- Option 3 would not establish any new requirements.

EPA estimated that Option 1 would cost approximately $130 million annually, while preventing the annual discharge of approximately 5.25 million tons of Total Suspended Solids (TSS) and associated turbidity to surface waters. The estimated annual monetized benefits of this option are $10.4 million. Option 2 is estimated to cost approximately $505 million annually, while preventing the discharge of approximately 11.1 million tons of TSS and associated turbidity to surface waters annually. The estimated annual monetized benefits of Option 2 are $22.0 million. Option 3 is not expected to have any costs or benefits.

SECTION 2: BACKGROUND

2.1 LEGAL AUTHORITY

The Environmental Protection Agency (EPA) is proposing Effluent Limitation Guidelines for discharges associated with construction and development activities under the authority of Sections 301, 304, 306, 308, 402, and 501 of the Clean Water Act (CWA) (the Federal Water Pollution Control Act), 33 United States Code (U.S.C.) 1311, 1314, 1316, 1318, 1342, and 1361. This section describes EPA's legal authority for issuing the regulation, existing state regulations, and other federal regulations associated with construction and development activities.

2.2 CLEAN WATER ACT

Congress adopted the Clean Water Act (CWA) to "restore and maintain the chemical, physical, and biological integrity of the nation's waters" (Section 101(a), 33 U.S.C. 1251(a)). To achieve this goal, the CWA prohibits the discharge of pollutants into navigable waters except in compliance with the statute. CWA sec. 402 requires "point source" discharges to obtain a permit under the National Pollutant Discharge Elimination System (NPDES). These permits are issued by EPA regional offices or authorized State agencies.

Following enactment of the Federal Water Pollution Control Amendments of 1972 (Pub.L. 92-500, October 18, 1972), EPA and the States issued NPDES permits to thousands of dischargers, both industrial (e.g. manufacturing, energy and mining facilities) and municipal (sewage treatment plants). As required under Title III of the Act, EPA promulgated effluent limitation guidelines and standards for many industrial categories, and these requirements are incorporated into the permits.

The Water Quality Act of 1987 (Pub.L. 100-4, February 4, 1987) amended the CWA. The NPDES program was expanded by defining municipal and industrial storm water discharges as point sources. Industrial storm water dischargers, municipal separate storm sewer systems and other storm water dischargers designated by EPA must obtain NPDES permits pursuant to Section 402(p) (33 U.S.C. 1342(p)).

2.2.1 BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

In guidelines for a point source category, EPA may define BPT effluent limits for conventional, toxic,[1] and non-conventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers the age of the equipment and facilities, the processes employed and any required process changes, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements), and such other factors as the Agency deems appropriate (CWA sec. 304(b)(1)(B)). Traditionally, EPA establishes BPT effluent limitations based on the average of the best performance of facilities within the category of various ages, sizes, processes or other common characteristics. Where existing performance is uniformly inadequate, EPA may require higher levels of control than currently in place in a category if the Agency determines that the technology can be practically applied. (US Senate, 1973, p. 1468).

In addition, the Act requires a cost-reasonableness assessment for BPT limitations. In determining the BPT limits, EPA considers the total cost of treatment technologies in relation to the effluent reduction benefits achieved. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are "wholly out of proportion to the costs of achieving such marginal level of reduction." (US Senate, 1973, p. 170) Moreover, the inquiry does not require the Agency to quantify benefits in monetary terms. See, for example, *American Iron and Steel Institute v. EPA*, 526 F. 2d 1027 (3rd Cir., 1975).

In balancing costs against the benefits of effluent reduction, EPA considers the volume and nature of expected discharges after application of BPT, the general environmental effects of pollutants, and the cost and economic impacts of the required level of pollution control. In past effluent limitation guidelines and standards, BPT cost-reasonableness removal figures have ranged from $0.21 to $33.71 per pound removed in year 2000 dollars. In developing guidelines, the Act does not require consideration of water quality problems attributable to particular point sources, or water quality improvements in particular bodies of water. Accordingly, EPA has not considered these factors in developing the limitations being proposed today. See *Weyerhaeuser Company v. Costle,* 590 F. 2d 1011 (D.C. Cir. 1978).

[1] In the initial stages of EPA CWA regulation, EPA efforts emphasized the achievement of BPT limitations for control of the "classical" pollutants (e.g., TSS, pH, BOD_5). However, nothing on the face of the statute explicitly restricted BPT limitation to such pollutants. Following passage of the Clean Water Act of 1977 (Pub.L. 95-217, December 27, 1977) with its requirement for point sources to achieve best available technology limitations to control discharges of toxic pollutants, EPA shifted its focus to developing BAT limitations for the listed priority toxic pollutants.

2.2.2 BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

The 1977 amendments to the CWA required EPA to identify effluent reduction levels for conventional pollutants associated with BCT technology for discharges from existing point sources. BCT is not an additional limitation, but replaces Best Available Technology (BAT) for control of conventional pollutants. In addition to other factors specified in sec. 304(b)(4)(B), the CWA requires that EPA establish BCT limitations after consideration of a two- part "cost-reasonableness" test. EPA explained its methodology for the development of BCT limitations in July 1986 (51 FR 24974).

Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501). A primary pollutant of concern at construction sites, sediment, is measured as TSS.

2.2.3 BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

In general, BAT effluent guidelines (CWA sec. 304(b)(2)) represent the best existing economically achievable performance of direct discharging plants in the subcategory or category. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the processes employed, engineering aspects of the control technology, potential process changes, non-water quality environmental impacts (including energy requirements), and such factors as the Administrator deems appropriate. The Agency retains considerable discretion in assigning the weight to be accorded to these factors. An additional statutory factor considered in setting BAT is "economic achievability." Generally, EPA determines the economic achievability on the basis of the total cost to the subcategory and the overall effect of the rule on the industry's financial health. The Agency may base BAT limitations upon effluent reductions attainable through changes in a facility's processes and operations. As with BPT, where existing performance is uniformly inadequate, EPA may base BAT upon technology transferred from a different subcategory or from another category. In addition, the Agency may base BAT upon manufacturing process changes or internal controls, even when these technologies are not common industry practice.

2.2.4 NEW SOURCE PERFORMANCE STANDARDS

New Source Performance Standards (NSPS) reflect effluent reductions that are achievable based on the best available demonstrated control technology. New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the greatest degree of effluent reduction attainable through the application of the best available demonstrated control technology for all pollutants (i.e., conventional, non-conventional, and priority pollutants). In establishing NSPS, CWA sec. 306

directs EPA to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

2.2.5 PRETREATMENT STANDARDS FOR EXISTING SOURCES AND PRETREATMENT STANDARDS FOR NEW SOURCES

The CWA also defines standards for indirect discharges, i.e. discharges into publicly owned treatment works (POTWs). These are Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS) under sec. 307(b). Because EPA has identified no deliberate discharges directly to POTWs, EPA is not proposing PSES or PSNS for the Construction and Development Category. The information reviewed by the Agency indicates that the vast majority of construction sites discharge either directly to waters of the U.S. or through MS4s. In some urban areas, construction sites discharge to combined sewer systems (i.e., sewers carrying both storm water and domestic sewage through a single pipe) which lead to POTWs. Sediment is susceptible to treatment in POTWs, using technologies commonly employed such as primary clarification, and EPA has no evidence of interference, pollutant pass-through or sludge contamination.

2.2.6 EFFLUENT GUIDELINES SCHEDULE

Clean Water Act section 304(m) requires EPA to publish a plan every two years that consists of three elements. First, under sec. 304(m)(1)(A), EPA is required to establish a schedule for the annual review and revision of existing effluent guidelines in accordance with sec. 304(b). Section 304(b) applies to ELGs for direct dischargers and requires EPA to revise such regulations as appropriate. Second, under sec. 304(m)(1)(B), EPA must identify categories of sources discharging toxic or nonconventional pollutants for which EPA has not published BAT ELGs under sec. 304(b)(2) or new source performance standards under sec. 306. Finally, under sec. 304(m)(1)(C), EPA must establish a schedule for the promulgation of BAT and NSPS for the categories identified under subparagraph (B) not later than three years after being identified in the 304(m) plan. Section 304(m) does not apply to pretreatment standards for indirect dischargers, which EPA promulgates pursuant to sec. 307(b) and 307(c) of the Act.

On October 30, 1989, Natural Resources Defense Council, Inc. (NRDC), and Public Citizen, Inc., filed an action against EPA in which they alleged, among other things, that EPA had failed to comply with sec. 304(m). Plaintiffs and EPA agreed to a settlement of that action in a consent decree entered on January 31, 1992. (*Natural Resources Defense Council et al v. Whitman,* D.D.C. Civil Action No. 89-2980). The consent decree, which has been modified several times, established a schedule by which EPA is to propose and take final action for eleven point source categories identified by name in the decree and for eight other point source categories identified only as new or revised rules, numbered 5 through 12. EPA selected the Construction and Development category as the subject for New or Revised Rule #10. The decree, as modified, calls for the Administrator to sign a proposed ELG for the C&D category no later than May 15, 2002, and to take final action on that proposal no later than March 31, 2004. A settlement agreement between the parties, signed on June 28, 2000, requires that EPA develop regulatory options applicable to discharges from construction, development and redevelopment, covering site sizes included in the Phase I and Phase II NPDES storm water rules (i.e. one acre or greater). EPA is required to develop options including numeric effluent limitations for sedimentation and turbidity; control of construction site pollutants other than sedimentation and turbidity (e.g. discarded building materials, concrete truck washout, trash); BMPs for controlling post-construction runoff; BMPs for construction sites; and requirements to design storm water controls to maintain pre-development runoff conditions where practicable. The settlement also requires EPA to issue guidance to MS4s and other permittees on maintenance of post-construction BMPs identified in the proposed ELGs. Further discussion of approaches not pursued by EPA at this time may be found in the docket for today's proposal.

2.2.7 NPDES PHASE I AND II STORM WATER RULES

The National Pollutant Discharge Elimination System (NPDES) is a permit system established under the CWA to enforce effluent limitation. Operators of construction activities, including clearing, grading and excavation are required to apply for permit coverage under the NPDES Phase I and II storm water rules. Under the Phase I rule (promulgated in 1990), construction sites of 5 or more acres must be covered by either a general or an individual permit. General permits covering the Phase I sites have been issued by EPA regional offices and state water quality agencies. Permittees are required to develop storm water pollution prevention plans that include descriptions of BMPs employed, although actual BMP selection and design are at the discretion of permittees (in conformance with applicable state or local requirements).

Construction sites between 1 and 5 acres in size are subject to the NPDES Phase II storm water rule (promulgated in 1999). The construction activities covered under Phase II are termed small construction activities and exclude routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the facility. Under the Phase II program, NPDES permit requirements for construction activities are similar to the Phase I requirements because they will be covered under similar general permits.

2.3 POLLUTION PREVENTION ACT OF 1990

The Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13101 et seq., Pub. L. 101-508, November 5, 1990) makes pollution prevention the national policy of the United States. The PPA identifies an environmental management hierarchy in which pollution "should be prevented or reduced whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or release into the environment should be employed only as a last resort..." (42 U.S.C. 13103). In short, preventing pollution before it is created is preferable to trying to manage, treat or dispose of it after it is created. According to the PPA, source reduction reduces the generation and release of hazardous substances, pollutants, wastes, contaminants or residuals at the source, usually within a process. The term source reduction "...includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. The term 'source reduction' does not include any practice which alters the physical, chemical, or biological characteristics or the volume of a hazardous substance, pollutant, or contaminant through a process or activity which itself is not integral to or necessary for the production of a product or the providing of a service." In effect, source reduction means reducing the amount of a pollutant that enters a waste stream or that is otherwise released into the environment prior to out-of-process recycling, treatment, or disposal.

Although the PPA does not explicitly address storm water discharges or discharges from construction sites, the principles of the PPA are implicit in many of the practices used to reduce pollutant discharges from construction sites. These include controls that minimize the potential for erosion such as stabilization of disturbed areas as soon as practicable. These controls are described in section 5 of the Development Document.

2.4 STATE REGULATIONS

States and municipalities have been regulating discharges of runoff from construction and land development industry to varying degrees for some time. A compilation of state and selected municipal regulatory approaches was prepared to help establish the baseline for national and regional levels of control. Data were collected by reviewing state and municipal web sites, summary references, state and municipal regulations and storm water guidance manuals. All states (and the selected municipalities) were contacted to confirm the data collected and to fill in data gaps, however, only 87 percent of the state agencies and a much smaller percentage of municipalities responded. The state and municipal regulatory data are summarized in Section 3.3 and the complete data sheets are included in Appendix A.

2.5 REFERENCES

US Senate, 1973. *A Legislative History of the Federal Water Pollution Control Act Amendments of 1972.* U.S. Senate Committee of Public Works, Serial No. 93-1, January 1973. Washington, DC.

SECTION 3: DATA COLLECTION

3.1 INTRODUCTION

EPA gathered and evaluated technical and economic data from various sources in the course of developing the effluent limitation guidelines and standards for the construction and development industry. EPA used existing data sources to profile the industry with respect to general industry description, industry trends, environmental impacts, and erosion and sediment control best management practices (BMPs) and cost. This chapter details the data sources used in the development of this proposal.

3.2 LITERATURE SEARCH

A literature search was performed to obtain information on various BMPs that pertain to the construction and land development industry. Journal articles and professional conference proceedings were used to summarize the most recent BMP effectiveness data, design and installation criteria, applicability, advantages, limitations, and cost.

3.3 COMPILATION OF STATE AND MUNICIPAL EXISTING CONTROL STRATEGIES, CRITERIA, AND STANDARDS

A compilation of State and municipal regulations were prepared to determine national and regional approaches towards controlling construction site storm water. The data were collected by reviewing State and municipal web sites, summary references, and State and municipal regulations and storm water guidance manuals. States and municipalities were contacted to confirm the data collected and to fill in data not available by these methods. Not all State and municipal contacts responded or were able to provide the missing information sought. While 87 percent of the State agencies provided confirmation of the regulatory data collected for this study, a much smaller percentage of municipalities responded.

A summary of criteria and standards that are implemented by States and municipalities as of August 2000 are presented in Tables 3-1 and 3-2, respectively. State requirements are generally equal to or less stringent than municipalities that are covered under the federal Clean Water Act NPDES Storm Water Program because State requirements apply to all development within their boundaries including single site development and low to high density developments. NPDES Storm Water Program designated municipalities generally have a population of 100,000 or more and can collect and fund the resources necessary to design, implement, and monitor separate and potentially more stringent storm water management programs. Table 3-1 contains responses from 47 of the 54 State controlling agencies. The total is greater than 50 because Florida has 5 intrastate regional authorities. Some State data were uncertain and repeated contacts to the responsible State agencies to confirm the data were not returned. For the same reason, some of the data sought from municipal agencies also are not available for this report. Tables 3-1 and 3-2 are summaries of the regulatory controls used by States and municipalities as presented on Table A-1: State regulations on the control of construction phase storm water.

Many data were not readily available. Appendix A presents Tables A-1which includes all of the data that was collected.

The data collected reflect a cross section of the US geography but are representative primarily of municipalities that have a population of 100,000 or greater and relatively few municipalities of smaller population. Thirty-one municipalities are included in the summary tables, which is a relatively small data set compared to the approximately 240 municipalities with NPDES programs and nearly 3,000 municipalities nationwide. Therefore, the data presented for the States in Table 3-1 is fairly comprehensive while data for the municipalities presented in Table 3-2 is not comprehensive but does reflect the diversity of management techniques used at the municipal level.

Table 3-1. State or Regional Planning Authority Requirements for Water Quality Protection

Standard	Number of States with Requirement[a]	Percent of National Developed Acreage with Requirement	Percent of National Developed Acreage without Requirement	Percent of National Developed Acreage without Information
Solids or sediment percent reduction	11	24%	61%	15%
Numeric effluent limits for TSS, settleable solids, or turbidity	2	11%	76%	13%
Numeric design depth or volume for water quality treatment	22	53%	28%	19%
Habitat/biological measures	3	7%	80%	13%
Physical in-stream condition controls	8	17%	70%	13%
Water Quality or Effluent Monitoring Requirement	3	6%	83%	11%

[a] Florida has 5 Water Management Districts. If any of these Districts met a particular standard, the entire state annual developed acreage was counted.

Table 3-2. Municipal Planning Authority Requirements

Standard	**Percent of Municipalities Reviewed with Requirement**	**Percent of Municipalities Reviewed without Requirement**	**Percent of Municipalities without Information**
Design storm for peak discharge control	39%	45%	16%
Solids or sediment percent reduction	7%	77%	16%
Numeric design depth, storm, or volume for water quality treatment	–	–	–
Design storm for flood control	39%	16%	23%
Habitat/biological measures	3%	65%	32%
Physical in-stream condition controls	10%	58%	32%

Note: This table reflects data collected from 31 municipalities

Tables 3-1 and 3-2 indicate that the following key control measures are being employed by States and municipal/regional authorities to implement the NPDES Storm Water Program:

- Storm water controls designed for peak discharge control
- Storm water controls designed for water quality control
- Storm water controls designed for flood control
- Specified depths of runoff for water quality control
- Percent reduction of loadings for water quality control (primarily solids and sediments)
- Numeric effluent limits for water quality control (primarily total suspended solids, settleable solids, or turbidity)
- Control measures for biological or habitat protection
- Control measures for physical in-stream condition controls (primarily streambed and streambank erosion).

The water quantity control measures for peak discharge and runoff volume controls that apply to the post-development conditions typically are not applicable during the construction phase when the site is disturbed. Pollutant control measures are commonly required during the construction phase, though the requirements for post-development storm water management are broader and potentially more stringent.

3.4 OTHER DATA SOURCES

3.4.1 PHASE II STORM WATER RULE ECONOMIC ANALYSIS

The *Economic Analysis of the Final Phase II Storm Water Rule* (USEPA, 1999) estimated Phase II Storm Water Rule compliance costs for two major categories of pollutant controls for construction sites: erosion and sediment control BMPs and post-construction storm water management controls. Total costs for implementing the Phase II Rule encompass expenditures for installation of erosion and sediment control technologies, labor requirements for submitting a Notice of Intent (NOI) to be covered by a general permit, a Notification to Municipalities, a Storm Water Pollution Prevention Plan (SWPPP), and maintenance costs. Costs were derived on a per-site basis and then aggregated to the State and national level based on the number of building permits issued. As described in the Economic Analysis Report for the Phase II Rule, census data were used to project the annual number of construction permits by Standard Industrial Classification (SIC) Code and construction permit data from 14 municipalities were used to categorize construction activities by site size.

3.4.2 1997 USDA NATIONAL RESOURCE INVENTORY

The 1997 National Resources Inventory (NRI) (USDA, 2000) is a statistically based survey that has been designed and implemented to assess conditions and trends of soil, water, and related resources on non-Federal lands in the United States. The NRI is conducted every 5 years by the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS), in cooperation with the Iowa State University Statistical Laboratory. The inventory provides scientifically valid, timely, and relevant information that is used to formulate effective agricultural and environmental policies and legislation, implement resource conservation programs, and enhance the public's understanding of natural resources and environmental conditions.

The NRI is a compilation of natural resource information on non-Federal land in the United States–nearly 75 percent of the country’s land base. The inventory captures data on land cover and use, soil erosion, prime farmland, wetlands, habitat diversity, selected conservation practices, and related resource attributes at more than 800,000 scientifically selected sample sites. The NRI can be accessed at http://www.nrcs.usda.gov/technical/NRI/.

3.4.3 NATIONAL STORM WATER BMP DATABASE

The National Stormwater BMP Database, developed by the American Society of Civil Engineers (ASCE), is designed to be a source of reliable data to help improve water quality nationwide by sharing consistent and transferable information on the performance of storm water best management practices. The database helps water quality professionals across the United States learn about successful BMPs and apply proven methods to local water quality projects. The database is based on extensive screening of a bibliography of more than 800 existing BMP studies and was designed by national storm water experts on ASCE's Urban Water Resources Research Council. As of June 2002, the database contains data on 198 BMPs. Representative information provided for BMPs includes test site location, researcher contact data, watershed characteristics, regional climate statistics, BMP design parameters, monitoring equipment types, and monitoring data such as precipitation, flow, and water quality. The database can be accessed online at http://www.bmpdatabase.org.

3.4.4 BMP DESIGN MANUALS AND GUIDANCE DOCUMENTS DEVELOPED BY GOVERNMENTAL AND OTHER ORGANIZATIONS

A variety of manuals and documents were used to obtain information on design and effectiveness of various BMPs. Examples include: (1) State design manuals such as the *Virginia Erosion and Sediment Control Handbook* (http://www.dcr.state.va.us/sw/e&s-ftp.htm), the *Maryland Storm Water Design Manual* (http://www.mde.state.md.us/environment/wma/stormwatermanual), and the *Denver Urban Drainage Criteria Manual* (http://www.udfcd.org); (2) Guidance documents such as the *Texas Nonpoint Source Book* http://www.txnpsbook.org) and EPA's *National Menu of BMPs* (http://www.epa.gov/npdes/menuofbmps/menu.htm); and (3) Consensus design manuals such as manuals of practice on storm water design developed by ASCE and the Water Environment Federation (ASCE and WEF, 1992 and1998) were used to determine various management strategies. Links to on-line manuals and guidance documents are provided on EPA's website at http://www.epa.gov/waterscience/guide/construction/ .

3.5 REFERENCES

ASCE and WEF. 1992. *Design and Construction of Urban Stormwater Management Systems.* ASCE Manual and Report on Engineering Practice No. 77; WEF Manual of Practice No. FD-20. American Society of Civil Engineers, New York, NY. Water Environment Federation, Alexandria, VA. http://www.asce.org and http://www.wef.org .

ASCE and WEF. 1998. *Urban Runoff Quality Management.* ASCE Manual and Report on Engineering Practice No. 87; WEF Manual of Practice No. 23. American Society of Civil Engineers, Reston, VA. Water Environment Federation, Alexandria, VA. http://www.asce.org and http://www.wef.org .

USEPA. 1999. *Economic Analysis of the Final Phase II Storm Water Rule*. U.S. Environmental Protection Agency, Office of Wastewater Management. Washington, DC.

USDA. 2000. *1997 National Resources Inventory*. U.S. Department of Agriculture, National Resources Conservation Service, Washington, DC. http://www.nrcs.usda.gov/technical/NRI/.

SECTION 4: INDUSTRY PROFILE

4.1 INTRODUCTION

The construction sector is among the largest and most important sectors in the national economy, accounting for approximately 4 percent of the U.S. gross domestic product. During 1997, approximately 262,000 construction companies with payroll in the United States employed nearly 2.4 million workers nationwide. Another 1.6 million workers associated with construction activities were self-employed. The construction industry is divided into three major subsectors: general building contractors, heavy construction contractors, and special trade contractors. General contractors build residential, industrial, commercial, and other buildings. Heavy construction contractors build sewers, roads, highways, bridges, and tunnels. Special trade contractors typically provide carpentry, painting, plumbing, and electrical services.

Because the proposed effluent guidelines are being developed to address water quality issues, this document focuses on the construction subsectors most closely associated with land-disturbing activities. General contractors and heavy construction establishments are by definition the most likely to conduct activities that could affect water resources. It should be noted, however, that for individual projects responsibility for land-disturbing activities and potential impacts on water quality might not be obvious because general contractors often subcontract all or some of the actual construction work. Hence, the following subsections describe the subsector categories most likely to be responsible for land-disturbing activities at the national level.

4.2 INDUSTRY DESCRIPTION

4.2.1 INDUSTRY DEFINITION AND CLASSIFICATION OF SUBSECTORS BY NAIC AND SIC CODES

The construction and land development industry is classified in the 1997 North American Industry Classification System (NAICS, 1997) under Sector 23, Construction. NAICS 1997 is the system currently used for classifying industry establishments by type of economic activity. It replaced the U.S. Standard Industrial Classification (SIC) system.

Construction work includes new construction, additions, alterations, and repairs. Establishments identified as construction-management firms are also included. The construction sector is divided into three types of activities or subsectors:

- Subsector 233–Building, Developing, and General Contracting

  This subsector is made up of establishments responsible for the construction of building projects. Builders, developers, and general contractors, as well as land subdividers and land developers, are included in the subsector. The construction work may be done for others and performed by custom builders, general contractors, design builders, or turnkey contractors. This construction activity may be for sale as performed by speculative or operative builders.

- Subsector 234–Heavy Construction

  This subsector comprises establishments engaged in the construction of heavy engineering and industrial projects (except buildings), such as highways, power plants, and pipelines. Establishments in this subsector usually assume responsibility for entire nonbuilding projects, but they may hire subcontractors for some or all of the actual construction work. Special trade contractors are included in this group if they are engaged in activities primarily related to heavy construction, such as grading for highways. The kinds of establishments in this group include heavy-construction general contractors and design builders.

- Subsector 235–Special Trade Contractors

  This subsector comprises establishments engaged in specialized construction activities, such as plumbing, painting, and electrical work. The activities in this subsector may be subcontracted from builders or general contractors, or the work may be performed directly for project owners. Special trade contractors usually perform most of their work at the job site.

Table 4-1 provides a list of the 3-digit subsectors, 4-digit industry groups and 5-digit NAICS industries in the construction sector.

Table 4-1. 1997 NAICS Subsectors, Industry Groups, and Industries Performing Construction Activities That Might Disturb Land

1997 NAICS Sector 23 - Construction	
233	**Building, Developing, and General Contracting**
2331	Land Subdivision and Land Development
23311	Land Subdivision and Land Development
2332	Residential Building Construction
23321 23322	Single-family Housing Construction Multifamily Housing Construction
2333	Nonresidential Building Construction
23331 23332	Manufacturing and Industrial Building Construction Commercial and Institutional Building Construction
234	**Heavy Construction**
2341	Highway, Street, Bridge, and Tunnel Construction
23411 23412	Highway and Street Construction Bridge and Tunnel Construction
2349	Other Heavy Construction
23491 23492 23493 23499	Water, Sewer, and Pipeline Construction Power and Communication Transmission Line Construction Industrial Nonbuilding Structure Construction All Other Heavy Construction
235	**Special Trade Contractors**
2357	Concrete Contractors
23571	Concrete Contractors
2359	Other Special Trade Contractors
23593	Excavation Contractors

Before the creation of the NAICS, construction and land development industries were classified using the SIC system. Any data collected before January 1997 might still be classified under that system. SIC classifications are relevant to the effluent guidelines, because certain U.S. Bureau of the Census (BOC) data for the construction industry were collected until 1994 and therefore classified under the SIC system rather than the NAICS. Under the SIC system, industries that might perform land-disturbing activities were classified under Division C–Construction, and

Division H–Finance, Insurance, and Real Estate. These divisions include the following SIC major groups:

- SIC Major Group 15–Building Construction General Contractors and Operative Builders

  This group includes general contractors and operative builders primarily engaged in the construction of residential, farm, commercial, or other buildings. General building contractors who combine a special trade with their contracting are also included.

- SIC Major Group 16–Heavy Construction Other Than Building Construction Contractors

  This group includes general contractors primarily engaged in heavy construction other than building construction, such as highways and streets, bridges, sewers, railroads, irrigation projects, flood control projects, and marine construction, as well as special trade contractors primarily engaged in activities of a type clearly specialized in such heavy construction and not normally performed on buildings or building-related projects.

- SIC Major Group 17–Construction Special Trade Contractors

  This group includes special trade contractors who undertake activities of a type that are specialized either in building construction or in both building and nonbuilding projects.

- SIC Major Group 65–Real Estate

  This group includes real estate operators and the owners and lessors of real property, as well as buyers, sellers, developers, agents, and brokers.

Major groups 15 and 16 are further defined by the type of construction performed. Table 4-2 provides a list of the more specific industry groups and industries that might perform land-disturbing activities.

Table 4-2. 1987 SIC Industry Groups Performing Construction Activities That May Disturb Land

SIC Major Group 15	
Industry Group 152: General Building Contractors - Residential	
1521	General Contractors - Single-family Houses
1522	General Contractors - Residential Buildings, Other Than Single-family
Industry Group 153: Operative Builders	
1531	Operative Builders
Industry Group 154: General Building Contractors - Nonresidential	
1541	General Contractors - Industrial Buildings and Warehouses
1542	General Contractors - Nonresidential Buildings, Other Than Industrial
SIC Major Group 16	
Industry Group 161: Highway and Street Construction, Except Elevated Highways	
1611	Highway and Street Construction, Except Elevated Highways
Industry Group 162: Heavy Construction, Except Highway and Street	
1622	Bridge, Tunnel, and Elevated Highway Construction
1623	Water, Sewer, Pipeline, and Communications and Power Line
1629	Heavy Construction Not Elsewhere Classified
SIC Major Group 17	
Industry Group 179: Miscellaneous Special Trade Contractors	
1771	Concrete Work
1794	Excavation Work
SIC Major Group 65	
Industry Group 655: Land Subdividers and Developers	
6552	Land Subdividers and Developers, Except Cemeteries

The focus of this Development Document is on construction activities carried out by firms covered by NAICS codes 233 and 234 or SIC codes 15 and 16. (As discussed in Section VI.A in the preamble of the proposed rule, Special Trade Contractors, NAICS 235 or SIC 17, are typically subcontractors and not identified as NPDES permittees.) Furthermore, the residential, non-residential, and heavy construction subsectors receive the greatest emphasis, because they account for the vast majority of construction projects and are responsible for most of the land disturbance in the United States. The following subsections describe these subsectors in terms of size, distribution, and recent growth trends.

4.2.2 RESIDENTIAL BUILDING CONSTRUCTION GROUP

Residential Construction Industry Description. The U.S. Bureau of the Census (BOC), a division of the Department of Commerce (DOC), divides the residential construction industry into two categories. The first encompasses single-family housing construction and includes mobile homes, prefabricated houses, row houses, town houses, and single-family detached houses. The second encompasses multifamily housing construction and includes high-rise apartments, garden apartments, and town house apartments in which units are not separated by ground-to-roof walls.

Historic Trends. The DOC began collecting detailed information on housing starts in 1963. Data on housing permits and starts are published monthly by the DOC and are viewed by economists as leading indicators of economic activity. More detailed industry information is collected through the Census of Construction Industries (CCI), which is conducted every 5 years (in years ending in a 2 or a 7) as part of the Census Bureau's Economic Census program. These data provide the most detailed snapshot of the status of the construction industry. The CCI covers all employer establishments primarily engaged in construction as defined by the NAICS and includes nonresidential construction activities. Table 4-3 summarizes housing starts for the period from 1979 to 1999.

In Table 4-3, the number of construction starts is shown by regional location and type of structure. The table also provides national totals for both single- and multifamily housing starts (BOC, 2001). As shown in the table, single-family housing starts account for the majority of housing construction starts. Figure 4-1 combines single- and multifamily housing starts and graphically depicts annual changes during the 1997-1999 period. The number of construction starts for privately owned housing units has decreased from approximately 1.7 million starts in 1979 to roughly 1.6 million starts in 1999 (BOC, 2001).

Table 4-3. Annual Housing Construction Starts by Type and Region
(Starts are in thousands)

Year	United States	Northeast		Midwest		South		West	
		Single-family	Multi-family	Single-family	Multi-family	Single-family	Multi-family	Single-family	Multi-family
1979	1,745	123	55	243	106	522	225	306	165
1980	1,292	87	38	142	76	428	215	196	110
1981	1,084	84	33	110	55	363	198	148	92
1982	1,062	79	37	99	50	357	234	127	78
1983	1,703	123	45	153	65	557	378	234	148
1984	1,750	158	46	167	76	528	338	230	206
1985	1,742	182	70	148	92	504	278	239	230
1986	1,805	228	66	188	108	504	229	261	222
1987	1,621	204	65	203	95	485	149	255	165
1988	1,488	181	54	194	80	443	132	264	140
1989	1,376	132	47	190	76	409	127	272	124
1990	1,193	104	27	193	60	371	108	226	103
1991	1,014	99	14	191	42	353	62	197	57
1992	1,200	112	15	236	52	439	58	244	45
1993	1,288	116	11	251	47	498	63	261	41
1994	1,457	123	16	268	61	522	117	286	65
1995	1,354	102	16	233	57	485	130	256	76
1996	1,447	112	20	254	68	524	138	271	90
1997	1,474	111	26	238	66	507	164	278	86
1998	1,617	122	26	223	58	573	169	303	92
1999	1,641	126	29	289	59	580	167	308	84

Source: BOC, 2001.

Housing start data tend to reflect the health of the U.S. economy. Therefore, as shown in Figure 4-1, the number of housing starts dropped significantly from 1986 to 1991 as the national economy fell into a recession. Conversely, the robust economy over the past several years has been accompanied by a strong growth in housing starts.

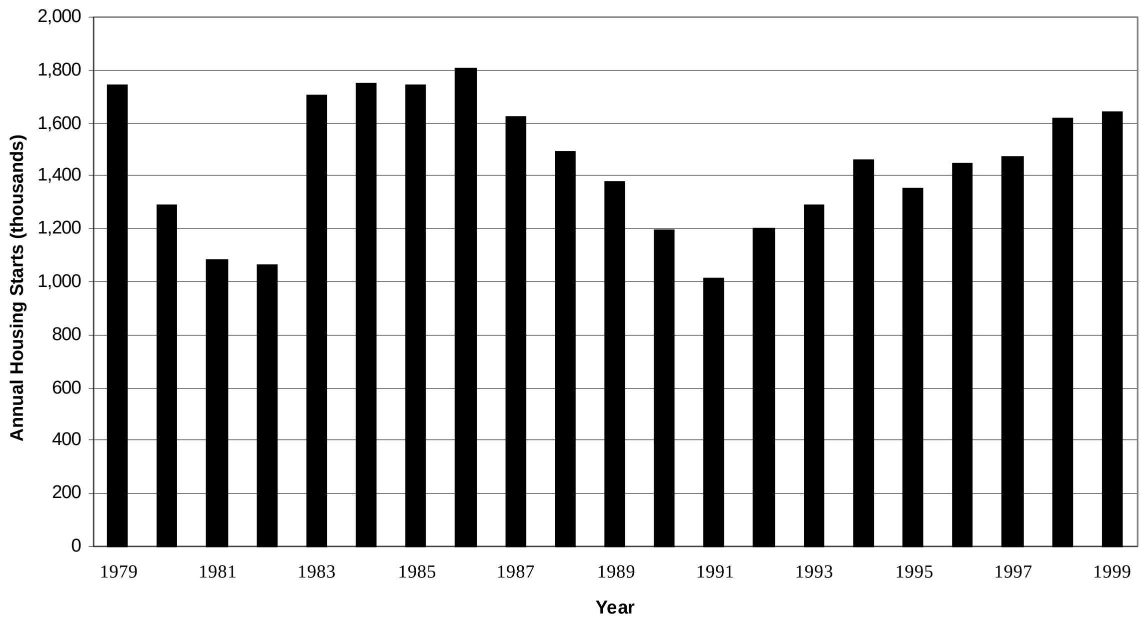

Figure 4-1. Annual Housing Starts

Industry Size. As a result of the recent strong growth in demand for new housing, the number of workers employed in residential construction has also increased. According to the BOC (1999b), the total number of employees in the housing construction industry rose from 452,257 in 1992 to 628,886 in 1997, an increase of almost 40 percent. Table 4-4 shows the number of workers employed, the payroll for those workers, and the value of completed construction for 1997. As shown in the table, the number of establishments and workers associated with construction of single-family housing greatly exceeds that for multifamily housing construction. It should also be noted that although construction of single-family homes is performed by both small and large firms, most multifamily housing construction is performed by large firms. Specifically, a special study by the Census Bureau (BOC, 2000a) found that about 39 percent of single-family homes are built by small builders (fewer than 25 units in the year); 21 percent by medium builders (25-99 units); and 40 percent by large builders (more than 100 units). In contrast, construction of multifamily housing is performed primarily by larger builders. During 1997, large builders constructed 77 percent of multifamily housing units.

The value of construction is defined as work done by general contractors, heavy construction contractors, and special trade contractors. Included in these estimates are new construction, additions, alterations or reconstruction, and maintenance and repair; the costs of industrial and other special equipment not an integral part of a structure are excluded. According to the 1997 Construction Census, the value of completed construction exceeded $161 billion. Single-family housing construction accounted for almost $147 billion, or more than 90 percent of the total.

Table 4-4. Residential Construction Industry Profile for 1997

	Single-Family Housing Construction	Multifamily Housing Construction
Total number of employees	570,990	58,896
Number of construction establishments during the year	138,849	7,543
Payroll (thousands)	$14,964,583	$1,794,143
Value of construction completed nationwide	$146,798,768	$14,487,308
State with the highest dollar value of construction work for establishments with payroll	California ($18,137,680)	Florida ($2,403,233)

Source: BOC, 1999b, 1999c.

Single-Family Housing Construction Trends. As noted earlier, housing construction starts increased significantly during the second half of the 1990s. In 1999, single-family home construction starts totaled more than 1.3 million, a level not reached since 1978 (BOC 2001).

As indicated in Table 4-5 by the number of permits issued, Atlanta, Georgia, led all U.S. major markets for single-family housing construction activity in 1999[1]. The other leading market areas for single-family construction were Phoenix, Arizona; Dallas-Ft. Worth, Texas; Chicago, Illinois; and Washington, D.C. Table 4-5 also shows the percent change in construction permits issued from 1998 to 1999 (U.S. Housing Markets, 1999a).

Multifamily Housing Construction Trends. Construction of structures with multiple housing units also increased significantly during the 1990s. For example, construction starts of these

[1] Permits issued do not necessarily translate into housing starts, since a permit issued in one year may not lead to actual construction until the next year. Furthermore, some permits issued never lead to actual construction. Nonetheless, permit counts can serve as a good indicator of construction activity in the near future.

buildings increased from about 173,500 in 1991 to more than 338,500 in 1999, an increase of about 95 percent.

Table 4-5. Busiest Markets for Single-Family Housing Permits for 1999

Market Area	Single-family Housing Permits (1999)	Percent Change From 1998
Atlanta	25,066	+11%
Phoenix	21,290	+13%
Dallas-Ft. Worth	17,434	+6%
Chicago	14,954	+7%
Washington, DC	14,703	0.07
Source: U.S. Housing Markets, 1999a.		

Much of the growth in multifamily housing was in the construction of facilities with more than five units. According to U.S. Housing Markets (1999b), the top five busiest markets for multifamily construction permits for 1999 were Dallas-Ft. Worth, Texas; Orlando, Florida; New York-Long Island; Puget Sound, Washington; and Houston, Texas. Table 4-6 shows the number of multifamily permits and the percent change in permits issued from 1998 to 1999.

Regional Housing Start Trends (Single-family and Multifamily Structures). The Census Bureau estimates housing starts at the regional level through statistical analysis of its survey data.

Table 4-6. Busiest Markets for Multifamily Housing Permits for 1999

Market Area	Multifamily Housing Permits (1999)	Percent Change From 1998
Dallas-Ft. Worth	8,488	-15%
Orlando	7,303	+46%
New York-Long Island	6,255	+55%
Puget Sound	6,122	+19%
Houston	5,900	-50%

Source: U.S. Housing Markets, 1999b.

As shown in Figure 4-2, the Census Bureau divides the United States into four regions: Northeast[2], Midwest [3], South[4], and West[5]. Table 4-7 summarizes changes in construction starts at the regional level for the years 1989 and 1999.

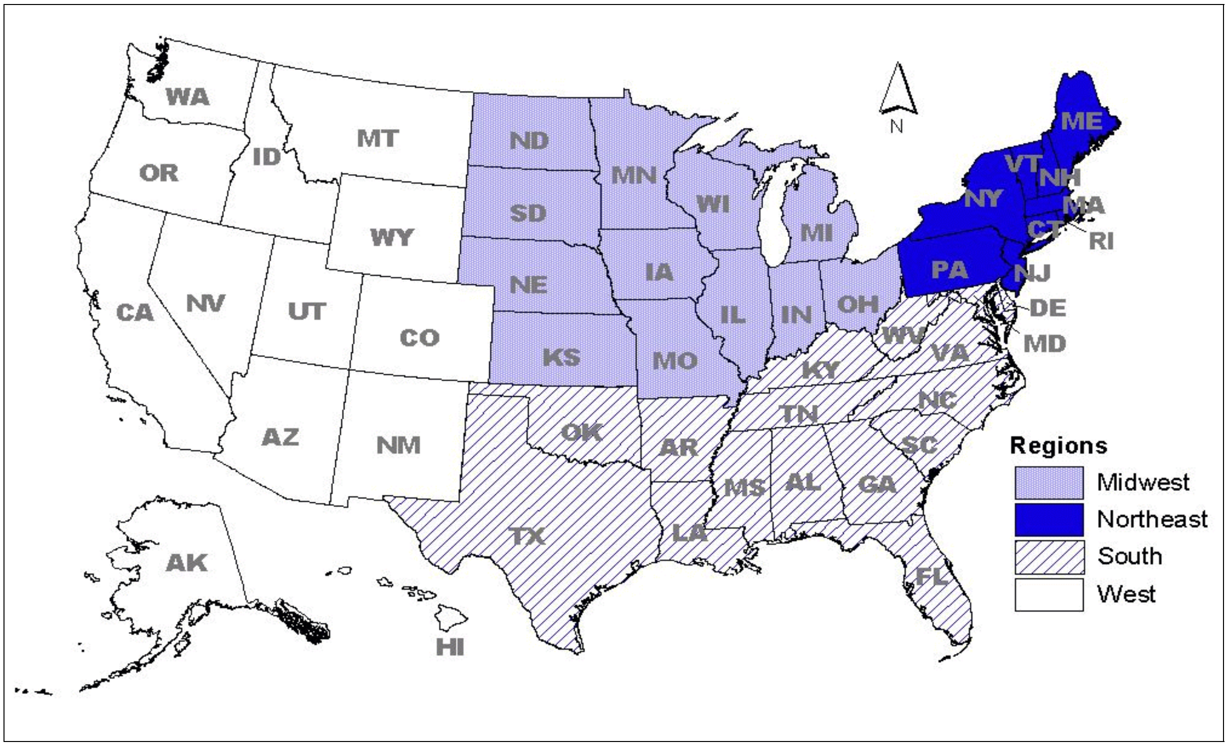

Figure 4-2. Bureau of Census Housing Regions

As noted earlier, national housing starts have increased significantly over the past decade. At the regional level, however, growth rates have varied to a large degree. As shown in Figure 4-3 and

[2] The Northeast includes the following states: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

[3] The Midwest includes the following states: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

[4] The South includes the following states: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

[5] The West includes the following states: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

summarized in Table 4-7, construction of housing increased by nearly 40 percent in the South, whereas construction starts in the Northeast actually decreased by almost 13 percent from 1989 levels. Housing starts in the Midwest also increased significantly over 1989 levels while housing starts in the West remained at about the same level as a decade earlier.

Table 4-7. Changes in Housing Starts by Region (1989 and 1999)

Region	1989 Housing Starts (in thousands)	1999 Housing Starts (in thousands)	Percent Change from 1989 to 1999
Northeast	178.5	155.7	-12.77
Midwest	265.8	347.3	30.66
South	536.2	746.0	39.13
West	395.7	391.9	-0.96
Total	1,376.1	1,640.9	19.24

Source: BOC, 1999a, 2001

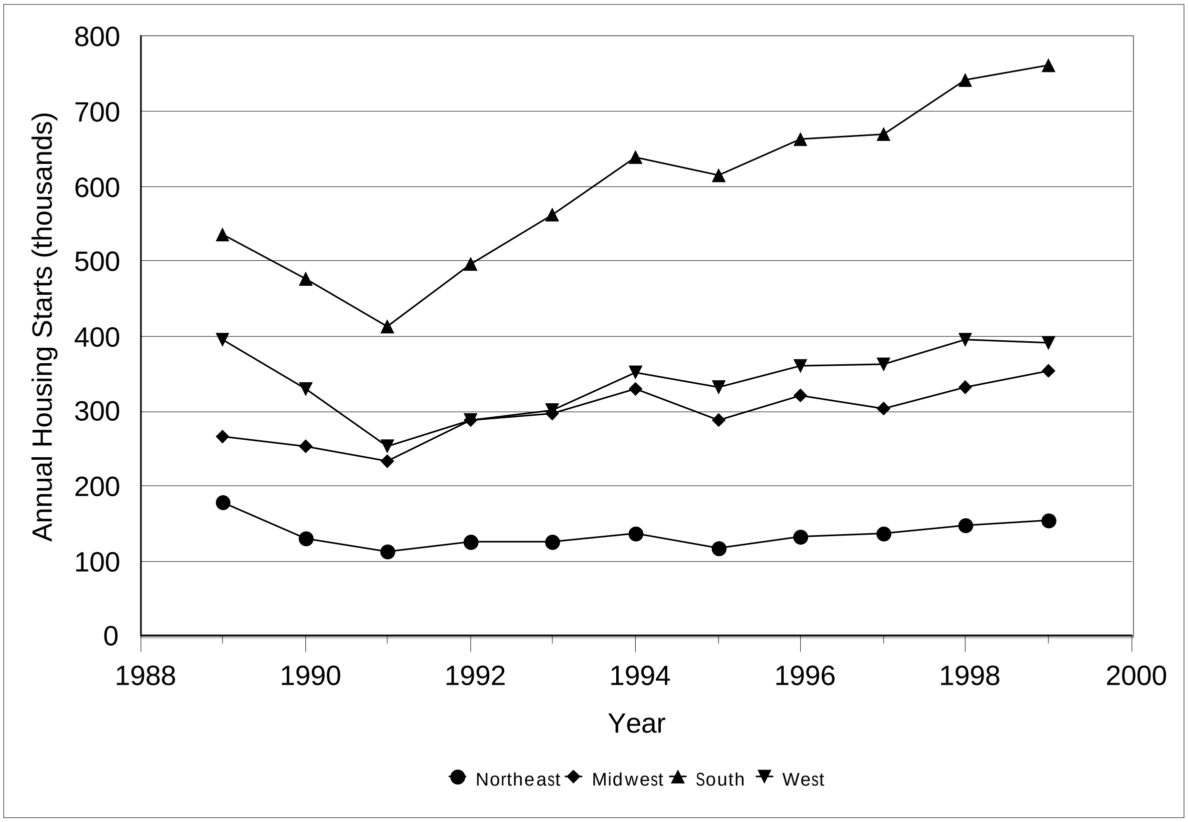

Figure 4-3. Annual Housing Starts by Region

4.2.3 NONRESIDENTIAL BUILDING CONSTRUCTION GROUP

The NAICS Nonresidential Building Construction group comprises establishments classified either as Manufacturing and Industrial Building Construction or Commercial and Institutional Building Construction. The following buildings are considered nonresidential by the U.S. Census Bureau and fall under either the manufacturing or the commercial classification: manufacturing and light industrial buildings; manufacturing and light industrial warehouses; hotels and motels; office buildings; all other commercial buildings not elsewhere classified, such as stores, restaurants, and automobile service stations; commercial warehouses; religious buildings; educational buildings; health care and institutional buildings; public safety buildings; nonresidential farm buildings; amusement, social, and recreational buildings; and all other nonresidential buildings. Because of the transition from the SIC system used in the 1992 Economic Census to the NAICS for the 1997 census, a valid comparison of data between the two censuses is not feasible, and therefore no historical data are shown.

Manufacturing and Industrial Building Construction. This industry type comprises establishments primarily responsible for the entire construction of manufacturing and industrial establishments, such as plants, mills, and factories. Establishments identified as management firms for manufacturing and industrial building construction are also part of this industry. They include manufacturing and industrial building general contractors, design builders, engineer-constructors, joint-venture contractors, and turnkey contractors (BOC, 1999e).

In 1997, there were 7,280 manufacturing and industrial building construction establishments with payroll (BOC, 1999e). These establishments employed 143,066 people for a total payroll of more than $5.1 billion. The total value of manufacturing and industrial building construction work in 1997 was more than $33.5 billion (BOC, 1999e). The value of construction work in 1997 by construction type is shown in Table 4-8 and includes new construction, additions, alterations or reconstruction, maintenance and repair, and any construction work done by the reporting establishments for themselves.

Table 4-9 shows the value U.S. of construction work for establishments with payroll by work location. States are grouped into four geographic regions: Northeast, Midwest, South, and West. The South and the Midwest each accounted for approximately one-third of total 1997 construction value (southern region, approximately 32.4 percent; Midwest, nearly 30.1 percent). The West and Northeast made up the remaining third (West, 23.4 percent; Northeast, 11.1 percent). Of the 50 states, California had the highest value of construction work at $3.4 billion, 10.1 percent of the total for the entire United States. Michigan had the second-highest amount at $2.9 billion (8.7 percent), followed by Texas at $1.9 billion (5.8 percent), and Ohio at $1.8 billion (5.3 percent). The remaining states and Washington, D.C., each had less than 5 percent of the total value of manufacturing and industrial building construction work in the United States in 1997.

Table 4-8. Value of Construction Work for Manufacturing and Industrial Building Construction Establishments With Payroll by Type of Construction, 1997

Type of Construction	Value of Construction Work (thousands of dollars)			
	Total	**New Construction**	**Additions, Alterations, or Reconstruction**	**Maintenance and Repair**
Manufacturing and Light Industrial Buildings	$17,590,062	$10,914,455	$4,280,143	$2,395,463
Manufacturing and Light Industrial Warehouses	7,058,148	5,421,819	1,358,864	277,466
Hotels and Motels	432,789	373,322	49,580	9,887
Office Buildings	2,478,594	1,570,275	810,808	97,511
All Other Commercial Buildings, Not Elsewhere Classified	1,141,600	799,522	298,166	43,912
Commercial Warehouses	1,040,691	883,412	131,005	26,275
Educational Buildings	823,028	541,081	255,540	26,407
Health Care and Institutional Buildings	862,907	464,788	355,116	43,003
All Other Nonresidential Buildings	1,580,244	1,073,758	436,029	70,457
Building Construction, Total	**33,008,063**	**22,042,431**	**7,975,252**	**2,990,381**
Nonbuilding Construction, Total[1]	503,956	316,697	123,832	63,427
Construction Work, Not Specified by Kind	2,324	Not Applicable	Not Applicable	Not Applicable
Manufacturing and Industrial Building Construction, Total[2]	**$33,514,342**	**$22,359,127**	**$8,099,084**	**$3,053,807**

1. This information is shown for the breakdown of total industrial building construction values.
2. Detail may not add to total because of rounding.
Source: BOC, 1999e.

Table 4-9. Value of Manufacturing and Industrial Building Construction Work for Establishments with Payroll by Location of Construction Work, 1997 (thousands of dollars)

Northeast		Midwest		South		West	
CT	$260,593	IL	$1,208,663	AL	$1,080,420	AK	$62,907
ME	170,314	IN	1,207,426	AR	182,142	AZ	561,785
MA	403,700	IA	381,922	DE	169,305	CA	3,440,637
NH	68,159	KS	281,419	DC	3,685	CO	330,551
NJ	755,854	MI	2,908,857	FL	920,179	HI	S
NY	920,425	MN	593,542	GA	1,090,761	ID	776,661
PA	1,114,271	MO	745,632	KY	861,206	MT	26,176
RI	D	NE	221,626	LA	521,420	NV	86,998
VT	14,812[1]	ND	89,251	MD	253,778	NM	377,538
		OH	1,772,426	MS	284,626	OR	895,078
		SD	D	NC	921,364	UT	314,621
		WI	669,575	OK	190,593	WA	915,678
				SC	689,581	WY	52,326
				TN	946,818		
				TX	1,934,909		
				VA	677,103		
				WV	144,481		
Total: $3,708,128[2]		Total: $10,080,339[2]		Total: $10,872,371[2]		Total: $7,840,956[2]	
Total Value of Construction for United States: 33,514,342[2]							

D: Withheld to avoid disclosing data of individual companies; data are included in United States total.
S: Withheld because estimates did not meet publication standards.
1. Sampling error exceeds 40 percent.
2. Totals for regions do not include states with "S" and "D" criteria.
Source: BOC, 1999e.

Commercial and Institutional Building Construction. This industry type comprises establishments primarily responsible for the entire construction of commercial and institutional buildings, such as stores, schools, hospitals, office buildings, and public warehouses (BOC, 1999d). Establishments identified as management firms for commercial and institutional building construction are also part of this industry type, which includes commercial and institutional building general contractors, design builders, engineer-constructors, joint-venture contractors, and turnkey contractors (BOC, 1999d).

In 1997, there were 37,430 commercial and institutional building construction establishments in the United States employing a total of 528,173 people, with a payroll of $19.2 billion (BOC, 1999d). The value of construction work in 1997 by construction type is shown in Table 4-10. Value includes new construction, additions, alterations or reconstruction, maintenance and repair, and any construction work done by the reporting establishments for themselves (BOC, 1999d).

Table 4-11 shows the value of commercial and institutional building construction work by location. The data are reported by state, by region (Northeast, Midwest, South, and West), and for the entire United States. The South had the highest dollar value of construction activity, accounting for $47.9 billion (27.7 percent) of commercial and institutional building construction in the entire U.S. The West accounted for 20.6 percent of the total, followed by the Midwest at 16.8 percent, and then the Northeast at 9.7 percent. Of the 50 states, California had the highest value of commercial and institutional construction work at $18 billion, or 10.4 percent of the total for the entire United States. Texas had the second highest value of construction at approximately $13 billion (7.5 percent), followed by Illinois at $7.9 billion (4.5 percent), and then Georgia at $7.1 billion (4.1 percent). The remaining states and Washington, D.C. each accounted for less than 4 percent of the total value of commercial and institutional building construction work in the United States in 1997.

Table 4-10. Value of Construction Work for Commercial and Institutional Building Construction Establishments With Payroll by Type of Construction, 1997

Type of Construction	Value of Construction Work (thousands of dollars)			
	Total	New Construction	Additions, Alterations, or Reconstruction	Maintenance and Repair
Single-Family Houses, Detached and Attached	$2,690,846	$1,473,065	$1,000,110	$217,672
Apartment Buildings, Apartment.-Type Condominiums and Cooperatives	4,081,493	2,905,159	1,016,097	160,237
Manufacturing and Light Industrial Buildings	8,083,739	5,201,932	2,425,390	456,417
Manufacturing and Light Industrial Warehouses	3,325,768	2,428,651	776,335	120,783
Hotels and Motels	8,313,559	6,433,138	1,679,856	200,564
Office Buildings	36,147,979	21,235,715	13,524,406	1,387,858
All Other Commercial Buildings, Not Elsewhere Classified	32,715,012	21,866,915	9,631,103	1,216,994
Commercial Warehouses	6,929,460	5,465,600	1,215,709	248,151
Religious Buildings	4,324,007	2,870,724	1,342,559	110,724
Educational Buildings	23,974,844	15,587,110	7,893,507	494,227
Health Care & Institutional Buildings	17,446,710	11,187,636	5,917,408	361,666
Public Safety Buildings	5,345,602	4,183,179	1,064,693	97,730
Farm Buildings, Nonresidential	1,904,128	1,508,380	272,836	122,912
Amusement, Social, and Recreational Buildings	6,529,907	5,141,460	1,275,033	113,414
Other Building Construction	3,429,673	1,984,749	895,522	549,401
Building Construction, Total	**166,818,246**	**110,618,170**	**50,325,006**	**5,875,070**

Type of Construction	Value of Construction Work (thousands of dollars)			
	Total	New Construction	Additions, Alterations, or Reconstruction	Maintenance and Repair
Nonbuilding Construction[1]	4,091,548	2,697,377	1,205,513	188,658
Construction Work, Not Specified by Kind	2,295,888	Not Applicable	Not Applicable	Not Applicable
Commercial and Institutional Building Construction, Total[2]	**$173,205,680**	**$113,315,547**	**$51,530,519**	**$6,063,728**

1. This information is shown for the breakdown of total industrial building construction values.
2. Detail may not add to total because of rounding.
Source: BOC, 1999d.

Table 4-11. Value of Commercial and Institutional Building Construction Work for Establishments With Payroll by Location of Construction Work, 1997 (thousands of dollars)

Northeast		Midwest		South		West	
CT	D	IL	7,860,551	AL	D	AK	509,429
ME	385,818	IN	3,132,116	AR	D	AZ	3,287,644
MA	4,518,815	IA	1,610,654	DE	891,394	CA	18,093,906
NH	697,186	KS	1,609,747	DC	1,724,839	CO	3,728,688
NJ	4,973,021	MI	4,791,024	FL	D	HI	D
NY	D	MN	3,361,074	GA	7,134,326	ID	D
PA	5,966,516	MO	D	KY	1,961,212	MT	342,606
RI	D	NE	895,824	LA	1,855,800	NV	D
VT	303,481	ND	297,619	MD	3,693,531	NM	913,252
		OH	5,620,984	MS	D	OR	2,599,182
		SD	D	NC	5,949,386	UT	1,796,639
		WI	D	OK	D	WA	4,155,050
				SC	2,417,316	WY	211,989
				TN	3,751,331		
				TX	12,953,464		
				VA	5,076,575		
				WV	529,092		
Total: $16,844,837[1]		Total: $29,179,593[1]		Total: $47,938,266[1]		Total: $35,638,385[1]	
Total Value of Construction for United States: $173,205,680[2]							

D: Withheld to avoid disclosing data of individual companies; data are included in United States total.
1. Totals for regions do not include states with "D" criteria.
2. Detail may not add to total because of rounding, and because of "D" criteria.
Source: BOC, 1999d.

4.2.4 HEAVY CONSTRUCTION SUBSECTOR

Industry Overview. The heavy construction industry encompasses broad types of activities with highway and street construction; bridge and tunnel construction; and water, sewer, and pipeline construction as the three main types of heavy construction. The U.S. Census Bureau administers a separate economic census for each of these three types of construction activities.

In general, most of the heavy construction industry indicators (e.g., value of completed work; employment) have increased over the past two decades, although the health of the industry, like that of the housing subsector, is closely tied to the overall state of the U.S. economy. This subsector has experienced both upturns and downturns over the past 20-year period.

The period encompassing the two most recent census years, 1992 and 1997, saw modest growth in the heavy construction subsector. By 1997, the value of construction completed by the three main types of heavy construction reached about $80 billion. As shown in Table 4-12, the highway construction category of the heavy construction subsector accounted for about 60 percent of the total value of heavy construction. Highway construction employed the majority of workers in the heavy construction subsector, accounting for about 278,000 of a total of 488,000 employees for all three categories of heavy contruction (BOC, 1999g). Of the three heavy construction categories, only the water, sewer, and pipeline category has experienced a decline in number of establishments and number of employees.

Regional Distribution of Heavy Construction Activities. The U.S. Bureau of Census reports data for the heavy construction industries at the state and regional levels. As in the case of the housing subsector, the Census Bureau divides the United States into four major regions, Northeast, Midwest, South, and West, each contributing to the total value of construction work. As shown in Figure 4-4, the South and Midwest accounted for the majority of the establishments and value of heavy construction work in 1997. In particular, these two regions accounted for 55 percent of the construction firms and 61 percent of the value of construction.

Of the three major types of heavy construction activities, highway and street construction accounted for almost 60 percent of the total value of heavy construction activities in 1997. The distribution of highway construction establishments and the value of completed work among the different regions of the country are similar to those of the other heavy construction categories For example, the South contributed more than $16 billion, or 34 percent, to the total value of highway construction work in the United States. It should be reiterated, however, that the census provides only a snapshot and that construction activities such as highway construction are dependent on government funding and can change significantly in magnitude and location over time.

Table 4-12. Overview of Heavy Construction Industry, 1992 and 1997

Year	Highway	Bridges	Water, Sewer, and Pipeline
Value of Construction (thousands of dollars)			
1992	35,331,607	7,198,275	20,205,048
1997	48,472,284	9,539,041	22,204,058
Number of Establishments			
1992	10,090	1,041	10,233
1997	11,270	1,177	8,042
Number of Employees [1]			
1992	257,356	43,701	194,252
1997	277,979	47,764	162,566

1. Number of employees is the sum of all employees during the pay periods that include the 12th of March, May, August, and November, divided by four.
Source: BOC, 1992a, 1992b, 1992c, 1999f, 1999g, 1999h.

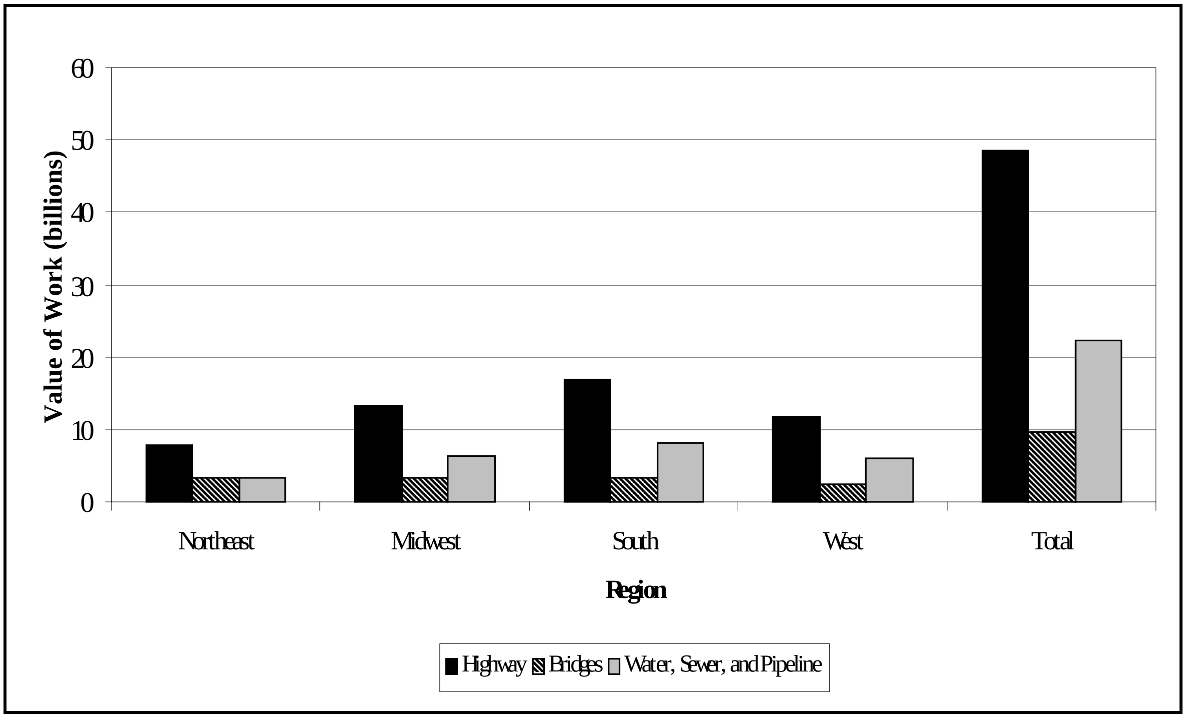

Figure 4-4. Value of Heavy Construction Work by Region, 1997

4.3 INDUSTRY PRACTICES AND TRENDS

4.3.1 OVERVIEW OF CONSTRUCTION LAND-DISTURBING ACTIVITIES

Constructing a building or facility involves a variety of activities, including the use of equipment that alters the site's environmental conditions. These changes include vegetation and top soil removal, regrading, and drainage pattern alteration. The following provides a brief description of typical land-disturbing activities at construction sites and the types of equipment employed.

Construction Site Preparation. Construction activities generally begin with the planning and engineering of the site and site preparation. During this stage, mobile offices, which are usually housed in trailers, are established on the construction site. The construction company uses these temporary structures to handle vital activities such as preparing and submitting applicable permits, hiring employees and subcontractors, and ensuring that proper environmental requirements are met. The entire construction yard is delineated with erosion and sediment controls installed and security measures established. The latter includes installing fences and signs to warn against trespassing and to mark dangerous areas. After the site is secured, equipment is brought to the site (and is stored there throughout the construction period).

Clearing, Excavating, and Grading. Construction on any size parcel of land almost always calls for a remodeling of the earth (Lynch and Hack,1984). Therefore, actual site construction begins with site clearing and grading. Organic material cannot support the weight of buildings and should be removed from the top layer of ground. (Some developers stockpile the organic material for use during the landscaping phase of construction rather than paying for it to be hauled from the site.) Construction contractors are to ensure that earthwork activities meet local, State, and Federal regulations for soil and erosion control, runoff, and other environmental controls. The size of the site, extent of water present, soil types, topography, and weather determine the kinds of equipment used in site clearing and grading (Peurifoy and Oberlender, 1989). Material that will not be used on the site should be hauled away by tractor-pulled wagons, dump trucks, or articulated trucks (Peurifoy and Oberlender, 1989).

Equipment used for lifting excavated and cleared materials include aerial-work platforms, forwarders, cranes, rough-terrain forklifts, and truck-mounted cranes. In addition, track loaders are used for digging and dumping earth (Caterpillar, 2000; Construction Equipment On-Line, 1996-1998; Lynch and Hack, 1984; and Peurifoy and Oberlender, 1989).

Excavation and grading are performed by several different types of machines. These tasks can also be done by hand, but this is generally more expensive (Lynch and Hack, 1984). When grading a site, builders typically ensure that new grades are as close to the original as possible, to avoid erosion and storm water runoff (Lynch and Hack, 1984). Proper grading also ensures a flat surface for development and drains water away from constructed buildings.

Excavation and grading equipment includes backhoes, bulldozers (including the versatile tracked bulldozer), loaders, directional drilling rigs, hydraulic excavators, motor graders, scrapers, skid-steer loaders, soil stabilizers, tool carriers, trenchers, wheel loaders, and pipeliners. Equipment selection depends on functions to be performed and specific site conditions (Caterpillar, 2000; Construction Equipment On-Line, 1996-1998; Lynch and Hack, 1984; and Peurifoy and Oberlender, 1989). Therefore, multiple types of equipment are used throughout the clearing and grading process.

Self-transporting trenching machines, wheel-type trenching machines, and ladder-type trenching machines are also used during site excavation. Self-transporting trenching machines are used to create shallow trenches, such as for underground wire and cables. This type of machine has a bulldozer blade attached to the front, is highly maneuverable, and can be used to dig narrow, shallow trenches. Wheel-type trenching machines also dig narrow trenches, most often for water mains and gas and oil pipelines. Ladder-type trenching machines are used to dig deep trenches, such as for sewer pipes. These machines might have a boom mounted at the rear. Along the boom are cutter teeth and buckets that are attached to chains. As the machine moves, it digs dirt and moves it to the sides of the newly formed trench (Peurifoy and Oberlender, 1989).

Power shovels can also be used for excavating soils. They are used on all classes of earth that have not been loosened. For solid rock, prior loosening is often necessary. As materials are excavated, they are immediately loaded onto trucks or tractor-pulled wagons and hauled from the site (Peurifoy and Oberlender, 1989). Hydraulic excavators, with either a front or a back shovel, are also used to dig into the earth and to load a hauling vehicle. There are several categories of hydraulic excavators, including backhoes, back shovels, hoes, and pull shovels. Hydraulic excavators are one of the most widely used types of excavating equipment because of their ease of use and their ability to remove the earth that caves as it is moved. They are effective excavating machines, and they are easy to use in terms of loading some sort of hauling vehicle (Peurifoy and Oberlender, 1989).

Draglines, used to dig ditches or build levees, can transport soil within casting limits, thus eliminating the need for hauling equipment (Peurifoy and Oberlender, 1989). Draglines have a bucket that hangs from a cable. The bucket is brought through the dirt and toward the operator (Lynch and Hack, 1984). Draglines can be used on both wet and dry ground and can dig earth out of pits that contain water (Peurifoy and Oberlender, 1989). They are most useful for making large cuts and channels below the level of the machine as well as for making valleys, mounds, slopes, and banks (Lynch and Hack, 1984). Draglines have a lower output than power shovels, and do not excavate rock as well as power shovels (Peurifoy and Oberlender, 1989).

Draglines can be converted to clamshells by replacing the dragline bucket with a clamshell bucket. A clamshell is typically used for handling sand, gravel, crushed stone, sandy loam, and other loose materials; it is not efficient in handling compacted earth, clay, or other dense materials. A clamshell is lowered into a material, and the bucket closes on the material. It is then raised over a hauling vehicle and the materials deposited (Peurifoy and Oberlender, 1989).

Scrapers, either self-powered or drawn by tractors, dig and compact materials by taking up earth from its underside with toothed scoops and loading it into hauling vehicles. Scrapers are useful in removing earth and weak or broken rock, and for excavating hills and rock faces. Some scrapers are designed for long hauls; others with good traction are used on steep slopes (Lynch and Hack, 1984).

A crawler tractor, which pulls a rubber-tired self-loading scraper, is often used for short-haul distances. The crawler tractor uses a drawbar pull to load the scraper. It has good traction and can operate on muddy roads. It is, however, a slower vehicle and thus is more appropriate for shorter hauls.

Wheel-type tractor-pulled scrapers, which come in two- and four- wheel tractors, are used for longer hauling distances. Unlike the crawler tractor-pulled scrapers, the wheel-type tractor-pulled scrapers do not maintain good traction. Under such conditions, a helper tractor, such as a bulldozer, might be used (Peurifoy and Oberlender, 1989).

All these machines shape and compact the earth, a crucial site preparation step. In addition, earthwork activities might suggest that fill be brought in. In such cases, the fill should be spread in uniform, thick layers and compacted to a specified density with an optimum moisture content. Graders and bulldozers are the most common earth-spreading machines. Machines that compact include tractor-pulled sheep's foot rollers, smooth-wheel rollers, pneumatic rollers, and vibrating rollers, among other equipment (Peurifoy and Oberlender, 1989). Rollers and scarifiers are used either to compact or to break up the ground (Lynch and Hack, 1984).

In order to remove rock, it should first be loosened and broken up, usually through drilling or blasting. Drilling equipment includes jackhammers, wagon drills, drifters, churn rills, and rotary drills; each is designed to work on a specific size and type of rock. Dynamite and other explosives are used to loosen rock (Peurifoy and Oberlender, 1989).

Once materials have been excavated and removed and ground cleared and graded, the site is ready for construction.

4.3.2 CONSTRUCTION SITE SIZE CATEGORIES AND ESTIMATES OF AMOUNT OF DISTURBED LAND

The proposed effluent guidelines would apply to construction sites of all types (i.e., residential, commercial, and industrial) of more than one acre (5 acres, in the case of the guideline’s Option 2). Because the costs of best management practices (BMPs) for erosion and sediment control are largely driven by site size, EPA estimated the distribution of construction sites by size category, land use type, and geographic region in order to estimate the total cost of the proposed rule. (In addition, estimating distribution of sites by type allows EPA to estimate the cost to each construction sector.)

The method used to estimate the number of construction sites by size category, and therefore the total area disturbed, is based on a number of data sources, including U.S. Census data and data collected during the Phase II Storm Water rulemaking.

4.3.2.1 National Estimates of Disturbed Acreage

EPA used the U.S. Department of Agriculture’s (USDA’s) 1997 National Resources Inventory (NRI) to estimate the level of new U.S. development each year. (NRI is designed to track changes in land cover and land use over time.) The inventory, conducted every five years, covers all non-federal lands in the U.S. (75 percent of the U.S. total). The program captures land use data from some 800,000 statistically selected locations. From 1992 to 1997, an average of 2.2 million acres per year were converted from non-developed to developed status. Table 4-13 shows the allocation of this converted land area by type of land or land cover.

Table 4-13. Acres Converted from Undeveloped to Developed State[a], 1992-1997

Type of Land	Acres Converted to Development 1992-1997 (thousands) Annual Average	Percent Contribution by Type of Land
Cropland	574.8	26.6%
Conservation Reserve Program land	1.5	0.1%
Pastureland	391.2	17.4%
Rangeland	245.9	11.0%
Forest land	939.0	41.9%
Other rural area	89.1	4.0%
Water areas and federal land	1.8	0.1%
Total	2,243.4	100.0%

a. NRI defines *developed land* as a combination of the following land cover/use categories *large urban and built-up areas*, *small built-up areas*, and *rural transportation land*. These are defined as follows:
Large urban and built-up areas. A land cover/use category composed of developed tracts of at least 10 acres and meeting the definition of urban and built-up areas.
Small built-up areas. A land cover/use category consisting of developed land units of 0.25 to 10 acres, which meet the definition of urban and built-up areas.
Rural transportation land. A land cover/use category which consists of all highways, roads, railroads and associated right-of-ways outside urban and built-up areas; also includes private roads to farmsteads or ranch headquarters, logging roads, and other private roads (field lanes are not included).
Urban and built up areas are in turn defined as:
Urban and built-up areas. A land cover/use category consisting of residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; other land used for such purposes; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads , and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition but are completely surrounded by Urban and built-up land. Two size categories are recognized in the NRI: areas of 0.25 acre to 10 acres, and areas of at least 10 acres.
Source: USDA, 2000.

4.3.2.2 Distribution of Acreage by Project Type

To allocate the NRI acreage among the various segments of the industry, EPA has estimated the distribution of acres developed by type of project in the following way. First, EPA multiplied the number of building permits issued annually by estimates of the average site size for each project type. Thus for single-family residential construction, EPA multiplied the number of new single-family home building permits by the average lot size for new single-family construction. Estimates for other types of construction were based on extrapolations from the U.S. Census permit data and EPA estimates of average project size. Second, EPA adjusted the estimates of acres converted to reconcile any differences between the total number of acres accounted for using this approach and the total acres developed as estimated in the NRI.

Single-family Residential

Census data indicate that in recent years the number of new single-family housing units authorized has averaged just over 1.0 million units per year (see Table 4-14). The average lot size for new single-family housing units is 13,553 square feet, or 0.31 acres (1 acre = 43,560 square feet). Using the average lot size (see Table 4-15), however, will underestimate the total acreage converted for single-family residential projects because it does not include common areas of developments not counted as part of an owner's lot. These areas include streets, sidewalks, parking areas, storm water management structures, and open spaces.

Table 4-14. New Single-Family and Multifamily Housing Units Authorized, 1995-1997

Year	All Housing Units	Single-Family Housing Units	Multifamily Housing Units
1995	1,332,549	997,268	335,281
1996	1,425,616	1,069,472	356,144
1997	1,441,136	1,062,396	378,740
1995-1997 avg	1,399,767	1,043,045	356,722

Source: BOC, 2000b.

Table 4-15. Average and Median Lot Size for New Single-Family Housing Units Sold, 1995-1997

Year	Average Lot Size (Square Feet)	Median Lot Size (Square Feet)
1995	13,665	9,375
1996	13,705	9,100
1997	13,290	9,000
1995-1997 avg	13,553	9,158

Source: BOC, 1995, 1996, 1997.

To account for these differences, EPA examined data obtained from a survey of municipalities conducted in support of the Phase II Storm Water rule (EPA 1999). This survey identified 14 communities that consistently collected project type and size data as part of their construction permitting programs.[6] EPA's review of permitting data from these communities covered 852 single-family developments encompassing 18,134 housing units. The combined area of these developments was 11,460 acres. This means that each housing unit accounted for 0.63 acres (11,460 acres ÷ 18,134 units = 0.63 acres per unit). This estimate, essentially double the average lot size, appears to more than account for the common areas and undeveloped areas in a typical single-family residential development. For this reason, EPA averaged the Census estimate of the national average lot size (0.31 acres) and the Phase II estimate of 0.63 acres per unit to arrive at an estimate of 0.47 acres per unit. This number was multiplied by the average number of single-family housing units authorized by building permit, 1.04 million, to arrive at an estimate of 490,231 acres (see Table 4-18).

Multifamily Residential

For residential construction other than single-family housing, EPA divided the average number of units authorized during 1995-1997 (356,722, from Table 4-14) by the average number of units per new multifamily building. The average number of units per building was obtained by examining the distribution of units by unit size class in Census data (BOC 2000b). EPA estimated the number of buildings in each size class by dividing the number of units in each class by the average number of units. The total number of units was then divided into the estimated number of buildings to arrive at an average number of approximately 10 units per building across

[6] The communities were: Austin, TX; Baltimore County, MD; Cary, NC; Ft. Collins, CO; Lacey, WA; Loudoun County, VA; New Britain, CT; Olympia, WA; Prince George's County, MD; Raleigh, NC; South Bend, IN; Tallahassee, FL; Tuscon, AZ; and Waukesha, WI.

all building size classes. Dividing 356,722 units authorized (Table 4-14) by 10 units per building project yields 35,672 individual development projects.

EPA next examined data on the average site size for multifamily residential developments. The Center for Watershed Protection reports survey results showing that an average building footprint occupies 15.6 percent of the total site (CWP 2001). EPA assumed that the average-sized multifamily building (10.8 units) would have two floors and that each unit would occupy the national average of 1,095 square feet (NAHB 2002). The total square footage accounted for by living space is thus 11,826 square feet. Multiplying by a factor of 1.2 to account for common areas and other non-living space (utility rooms, hallways, stairways), and dividing by 2 to reflect the assumption of a 2-story structure, EPA obtained a typical building footprint of 7,096 square feet (11,826 x 1.2 ÷ 2 = 7,096). Combining this with the CWP estimate of the building footprint share of total site size (15.6 percent), the average site size was estimated to be 45,487 square feet (7,096 ÷ 0.156 = 45,487), or just over 1 acre (1.04 acres).

EPA compared the average site size obtained using this approach with data from the 14 community survey referenced above under the Phase II Storm Water rule. That study's review of permitting data identified 286 multifamily developments covering a total of 3,476 acres. The average site size, 12.1 acres, is considerably higher than that calculated above. EPA has no indication that the permits reviewed in these communities are for projects of a larger-than-average size. Therefore, for purposes of this analysis, EPA has taken the midpoint of the estimates, 6.5 acres, as the average size of multifamily projects. This number was multiplied by the average number of multifamily housing developments authorized by building permit, 35,672, to arrive at an estimate of 231,868 acres (see Table 4-18).

Nonresidential Construction

EPA lacked current data on the number of nonresidential construction and development projects authorized annually because the Census Bureau ceased to collect data on the number of permits issued for such projects in 1995. EPA used regression analysis to forecast the number of nonresidential building permits issued in 1997, based on the historical relationship between residential and nonresidential construction activity. Using this approach, EPA estimates that a total of 426,024 nonresidential permits were issued in 1997. These represent a variety of project types, including commercial and industrial, institutional, recreational, as well as nonresidential, nonbuilding projects such as parks and road or highway projects.

EPA first combined a number of project types into a larger "commercial" category, which included hotels and motels and retail and office projects, as well as religious, public works, and educational projects.[7] EPA's reasoning for including the latter categories under the commercial category is based on engineering judgment that erosion and sediment control practices would be similar across each project type. The total estimated number of commercial permits in 1997 was 254,566 (59.7 percent of the nonresidential total). (EPA calculated a estimate for the industrial category, which totaled 12,140 permits (2.8 percent), separately.) The residual 159,318 permits (37.4 percent), are nonbuilding, nonresidential projects that include parks, bridges, roads, and highways. EPA accounts for these projects in the steps described below.

For the industrial and commercial categories, EPA reviewed the project size data collected from the 14-community Phase II rule survey referenced earlier (EPA, 1999). This study identified 817 commercial sites occupying 5,514 acres and 115 industrial sites occupying 689 acres. The average site sizes are 6.7 and 6.0 acres, respectively.

EPA also reviewed estimates from CWP (2001) on the average percent of commercial and industrial sites taken up by the building footprint. These percentages, 19.1 and 19.6 respectively, were multiplied across the model project site sizes of 1, 3, 7.5, 25, 70, and 200 acres to estimate building size on each site, assuming single-story buildings in each case. These estimates are shown in Table 4-16.

Table 4-16. Average Building Area (square feet)

Project Size (Acres)	Commercial	Industrial
1	8,320	8,555
3	24,960	25,666
7.5	62,400	64,164
25	207,999	213,880
70	582,397	598,863
200	1,663,992	1,711,037

Estimates were obtained by multiplying the site size in square feet by the percentage of the site estimated to be occupied by the building "footprint," based on data from CWP (2001).

As seen in the table, the average building size corresponding to the 6- to7- acre sites estimated from the 14-community study are in the 60,000 square feet range. EPA next examined R.S.

[7] The commercial category included: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, and other nonresidential buildings.

Means' *Building Construction Cost Data* (2000), which provides cost data for "typical" commercial and industrial buildings. As part of the cost data, R.S. Means identifies the typical range of building sizes based on a database of actual projects. Table 4-17 shows the typical size and size range for a variety of building types that would fall into either the commercial or industrial category. While some of the building types correspond with the estimated average of 60,000 square feet, these appear high for other categories, such as low-rise office and supermarkets, warehouses, and elementary schools. EPA believes generally that there are more small projects than large ones. As a result, EPA inferred that this approach would suggest an average building size of 25,000 square feet, which implies an average site size of 3 acres, based on Table 4-16.

To reconcile the estimates obtained from the two approaches, EPA has taken the midpoint of the estimates. For commercial development, EPA assumes an average site size of 4.85 acres (the average of 6.7 and 3.0 acres) and for industrial development EPA assumes an average site size of 4.5 acres (the average of 6.0 and 3.0 acres).

Table 4-17. Typical Building Sizes and Size Ranges by Type of Building

Building Category/Type	Typical Size (Gross Square Feet)	Typical Range (Gross Square Feet)	
		Low	High
Commercial - Supermarkets	20,000	12,000	30,000
Commercial - Department Store	90,000	44,000	122,000
Commercial - Low-Rise Office	8,600	4,700	19,000
Commercial - Mid-Rise Office	52,000	31,300	83,100
Commercial - Elementary[a]	41,000	24,500	55,000
Industrial - Warehouse	25,000	8,000	72,000

a. For purposes of this analysis EPA combines a number of building types, including educational, under the commercial category.
Source: R.S. Means, 2000.

The resulting average project sizes were then multiplied by the estimated number of commercial and industrial permits to obtain an estimate of the total acreage developed (and thus land acreage disturbed) for these project categories. Table 4-18 shows the results of this "bottom-up" approach to estimating the number of acres of land developed. The overall estimate of the amount of land developed is 2.01 million acres per year. Residential single-family development accounts for 24.4 percent of the total, multifamily development for 11.5 percent of the total, commercial for 61.4 percent, and industrial for 2.7 percent.

Table 4-18. National Estimates of Land Area Developed Per Year, Based on Building Permit Data

Type of Construction		Permits		Average Site Size[a]	Acres Disturbed	
		Number	Pct. of Total		Number	Pct. of total
Residential	Single-family	1,043,045	77.5%	0.47	490,231	24.4%
	Multifamily	35,672	2.7%	6.5	231,868	11.5%
Nonresidential	Commercial[b]	254,566	18.9%	4.9	1,234,645	61.4%
	Industrial	12,140	0.9%	4.5	54,630	2.7%
Total		**1,345,423**	**100.0%**	**--**	**2,011,374**	**100.0%**

a. For single-family residential, this is the average of the average lot size for new construction in 1999 (BOC, 2000b) and the average obtained in EPA (1999). For all other categories, the site sizes are EPA assumptions based on representative project profiles contained in R.S. Means (2000) and the 14-community survey conducted in support of the Phase II NPDES storm water rule (EPA, 1999).
b. A number of project types were grouped together to form the "commercial" category, including: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, other nonresidential buildings.

The estimate of 2.01 million acres (Table 4-18) of annual construction is close to the estimated 2.24 million acres of annual new urban land obtained from 1997 NRI. Areas not accounted for in EPA's estimates include those converted as a result of road, highway, bridge, park, monument, and other non-building construction projects. EPA has not developed engineering costs applicable to these types of projects, but assumes that the builders and developers of these areas will face similar compliance costs per acre to the residential, commercial and industrial sectors, and therefore, the acreage should be included in EPA's analysis. For the purpose of developing national compliance costs, therefore, EPA has allocated the entire annual new urban acreage from the 1997 NRI into the four land use categories using the distribution shown in the final column of Table 4-18. The third column in Table 4-19 summarizes the results of this allocation. EPA next adjusted the annual developed acreage to account for sites that would not be required to obtain a permit due to the low rainfall erosivity waiver contained in the Phase II rule, as well as to eliminate sites less than 1 acre. EPA estimated based on the Phase II economic analysis that 33,517 acres would qualify for a low soil loss waiver, and analysis of the 14 community survey data indicates that 33,828 acres would be in sites less than 1 acre. This yields 67,345 acres of annual new development that would not be within the scope of the proposal. EPA allocated this acreage among the four land uses based on an analysis of the number of permits less than five acres contained within each respective segment. The results of this allocation are contained in the fourth column of Table 4-19, and the revised NRI acreage accounting for waivers and sites less than 1 acre is presented in the last column Table 4-19. EPA further estimated acreage that would be eliminated from coverage given the 5 acre cutoff contained in Option 2. A discussion of this analysis is included in the Economic Analysis supporting document.

Table 4-19. National Estimates of Land Area Disturbed Based on National Resources Inventory Totals

Type of Construction		Total NRI Acreage[a]	Acres Waived or not Covered	Adjusted NRI Acreage[b]
Residential	Single-family	546,783	12,905	533,878
	Multifamily	258,616	6,434	252,182
Nonresidential	Commercial[c]	1,377,070	44,594	1,332,476
	Industrial	60,932	3,412	57,523
Total		**2,243,400**	**67,345**	**2,176,058**

a. This column distributes the total acreage estimated in NRI to be converted on an annual basis (adjusted for waivers) according to the distribution by type of development estimated through analysis of permits data contained in Table 4-18.
b. This column presents the total national acreage estimated after adjusting for rainfall erosivity waivers and sites less than 1 acre.
c. A number of project types were grouped together to form the “commercial” category, including: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, other nonresidential buildings.

4.3.2.3 Distribution of Developed Acreage by Project Size and Geography

For each of the four land use categories in Table 4-19, EPA developed a distribution to allocate developed acre estimates among six different project size categories. The project size distribution is based on a survey of construction permits issued in 14 communities conducted in support of the Phase II storm water rule. Table 4-20 shows the distribution of the 14 community survey data by project size for each land use category. The percentages shown in Table 4-20 were used to allocate the total estimated development within each of the four land use sectors in Table 4-19 into six site size categories. The results of this analysis are presented in Table 4-21.

In addition, EPA developed procedures to spatially distribute land development regionally, using 19 ecoregions covering the contiguous states. A description of this methodology is presented in the Environmental Assessment supporting document.

Table 4-20. Distribution of 14 Community Survey Permits by Site Size

Site Size (Acres)	No. of Permits	Acres by Size	Pct. Acres by Size
Single-Family Residential			
1	266	266	2.3%
3	228	684	6.0%
7.5	138	1,035	9.0%
25	175	4,375	38.2%
70	30	2,100	18.3%
200	15	3,000	26.2%
Total	852	11,460	100.0%
Multifamily Residential			
1	43	43	1.2%
3	100	300	8.6%
7.5	61	458	13.2%
25	71	1,775	51.1%
70	10	700	20.1%
200	1	200	5.8%
Total	286	3,476	100.0%
Commercial			
1	266	266	4.8%
3	356	1,068	19.4%
7.5	86	645	11.7%
25	91	2,275	41.3%
70	16	1,260	22.9%
200	0	0	0.0%
Total	815	5,514	100.0%

Table 4-20. Distribution of 14 Community Survey Permits by Site Size

Site Size (Acres)	No. of Permits	Acres by Size	Pct. Acres by Size
Industrial			
1	39	39	5.7%
3	55	165	23.9%
7.5	10	75	10.9%
25	8	200	29.0%
70	3	210	30.5%
200	0	0	0.0%
Total	115	689	100.0%
Total			
1	614	614	2.9%
3	739	2,217	10.5%
7.5	295	2,213	10.5%
25	345	8,625	40.8%
70	59	4,270	20.2%
200	16	3,200	15.1%
Total	2,068	21,139	100.0%

Based on permitting data from the following municipalities or counties: Austin, TX; Baltimore County, MD; Cary, NC; Ft. Collins, CO; Lacey, WA; Loudoun County, VA; New Britain, CT; Olympia, WA; Prince George's County, MD; Raleigh, NC; South Bend, IN; Tallahassee, FL; Tucson, AZ; and Waukesha, WI.
Source: USEPA, 1999

Table 4-21. Distribution of National Construction by Site Size and Development Type

Site Size (Acres)	No. of Permits	Acres by Size	Pct. Acres by Size
Single-Family Residential			
1	12,392	12,392	2.3%
3	10,622	31,865	6.0%
7.5	6,429	48,217	9.0%
25	8,153	203,815	38.2%
70	1,398	97,831	18.3%
200	699	139,759	26.2%
Total	39,691	533,878	100.0%
Multifamily Residential			
1	3,120	3,120	1.2%
3	7,256	21,768	8.6%
7.5	4,426	33,196	13.2%
25	5,152	128,794	51.1%
70	726	50,792	20.1%
200	73	14,512	5.8%
Total	20,752	252,182	100.0%
Commercial			
1	64,280	64,280	4.8%
3	86,029	258,086	19.4%
7.5	20,782	155,866	11.7%
25	21,990	549,761	41.3%
70	4,350	304,483	22.9%
200	0	0	0.0%
Total	197,431	1,332,476	100.0%

Table 4-21. Distribution of National Construction by Site Size and Development Type

Site Size (Acres)	No. of Permits	Acres by Size	Pct. Acres by Size
Industrial			
1	3,256	3,256	5.7%
3	4,592	13,775	23.9%
7.5	835	6,262	10.9%
25	668	16,698	29.0%
70	250	17,532	30.5%
200	0	0	0.0%
Total	9,601	57,523	100.0%
Totals			
1	83,048	83,048	3.8%
3	108,498	325,494	15.0%
7.5	32,472	243,541	11.2%
25	35,963	899,067	41.3%
70	6,723	470,638	21.6%
200	771	154,271	7.1%
Grand Total	267,475	2,176,059	100.0%

Based on permitting data from the following municipalities or counties: Austin, TX; Baltimore County, MD; Cary, NC; Ft. Collins, CO; Lacey, WA; Loudoun County, VA; New Britain, CT; Olympia, WA; Prince George's County, MD; Raleigh, NC; South Bend, IN; Tallahassee, FL; Tuscon, AZ; and Waukesha, WI.
Source: USEPA, 1999.

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